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A Probabilistic Broadcasting Protocols in Mobile ad hoc Networks: A Bibliometric Survey

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Abstract:

Broadcasting in Mobile ad hoc network is very crucial process and if not taken care led to Broadcast storm problem. Several Broadcasting techniques are proposed in the literature, but probabilistic broadcasting is the one the major technique which can really avoid the broadcasting storm problem. The protocols employing probabilistic broadcasting is surveyed in this bibliometric paper. The bibliometric survey aims to throw light on several types of protocols employed in Mobile ad hoc Network. The primary aim of this paper is to assess the amount of work done in the field of Probabilistic Broadcasting in Mobile ad hoc Network, as well as to predict the future scope in this field. In this survey a bibliometric survey of last 15 years from 2005 to till date is done which is based on Scopus database.

Keywords: Scopus; Probablistic Broadcasting, MANET, Routing Protocols; Survey

1. Introduction

There are two types of wireless networks: wireless single-hop and wireless ad-hoc multi-hop networks. In the single-hop network the communication between nodes is done based on fixed infrastructure like base stations, access points as well as servers which are positioned in advance. A basic example of a fixed wireless network is shown in figure 1 which shows nodes like a smart phone and a tablet computer attached directly to a fixed wireless access point.

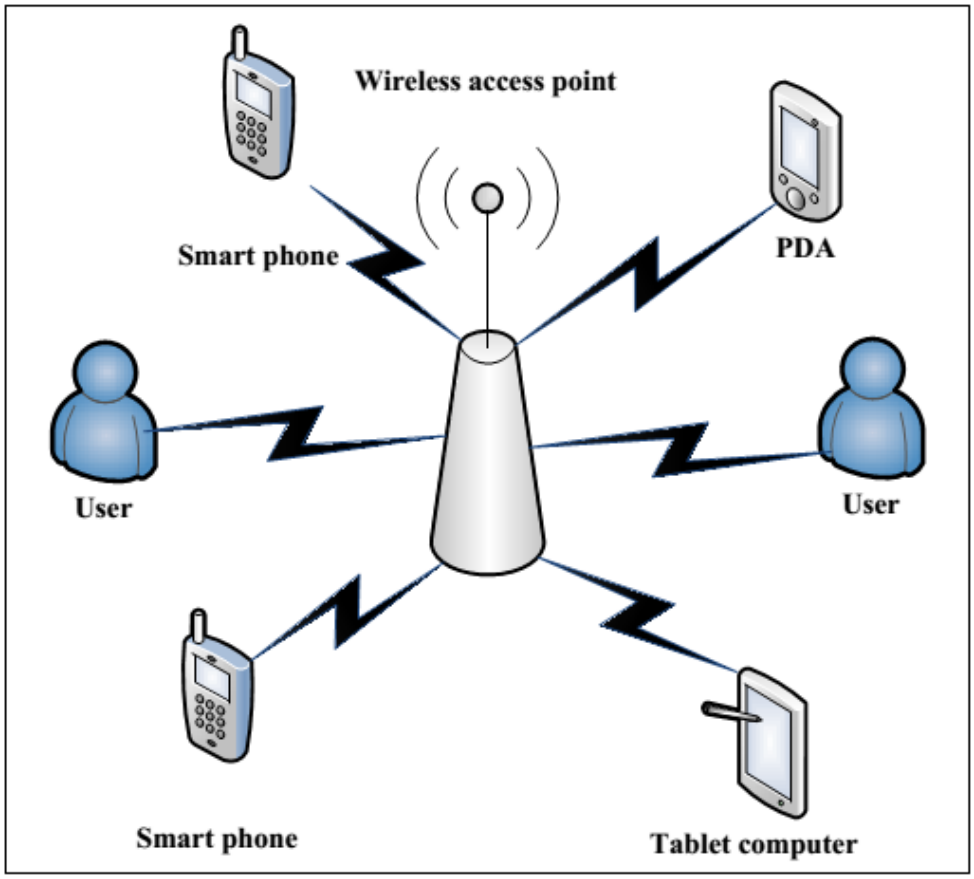

Figure 1. A fixed wireless Network.

But in the wireless ad-hoc network like Mobile ad hoc Networks (MANETs), communication between nodes is established through other intermediate or forwarding nodes. The nodes in mobile ad hoc networks are dynamically created with no requirement of fixed infrastructure. MANETs can be positioned and managed without the need to rely on a central infrastructure, which makes them valuable for many applications that run provisionally. A logical explanation of MANETs is shown in figure 2.

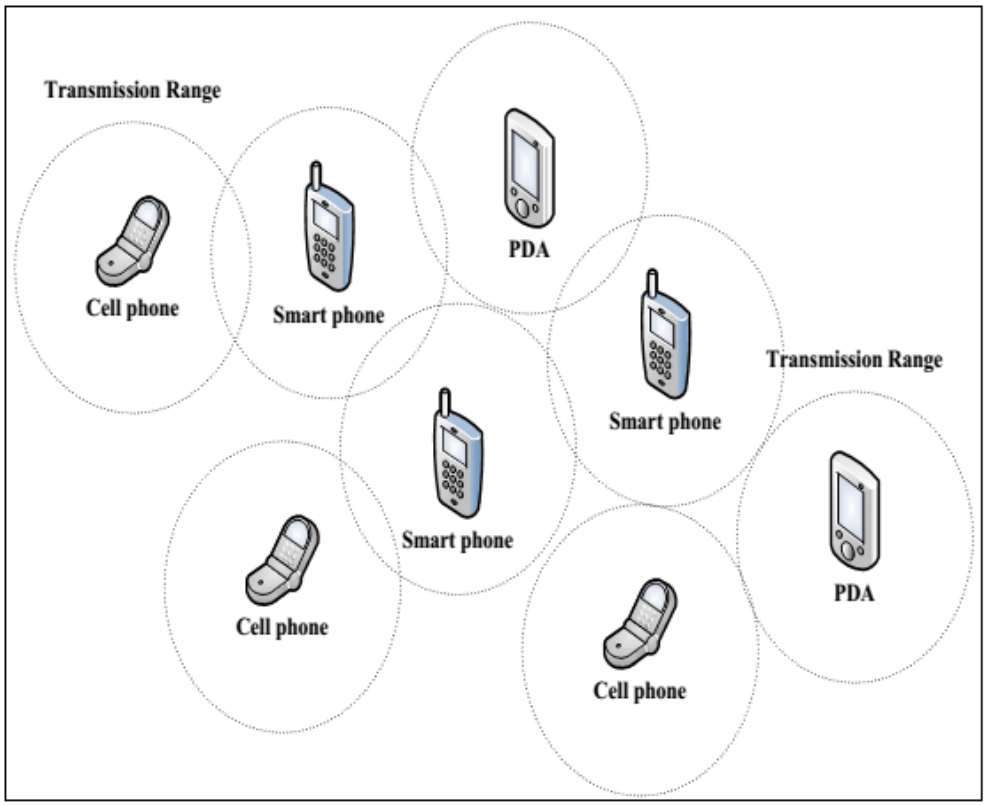

Figure 2. Mobile ad hoc Network

A MANET can be defined as the group of nodes which communicate with each other without having central infrastructure and it finds application where situation comes where central infrastructure is impossible to build like in natural calamities or war or at any far remote construction site. The bibliometric [1] analysis means measuring research in books, universities, countries, and journals. This is the first time to perform such a bibliometric analysis on the probabilistic broadcasting in MANET protocols. For this bibliometric [2] study, the authors have used the Scopus database available from last 15 years from 2005 to 18th May 2021. Various metrics of probabilistic broadcasting in MANET research are elaborated such as number of publications per year, number of publications in various reputed journals, document type, and country-wise the amount of research done on probabilistic broadcasting in MANET. This bibliometric study will serve as a pool of knowledge to the new researchers on the MANET area to understand the amount of research done and the scope of research in this probabilistic broadcasting in MANET field. After the introduction section, the detailed bibliometric analysis based on the Scopus database is done. Next network analysis on probabilistic broadcasting in MANET is done and then the paper is concluded. The different acronyms used in this paper are listed in Table 1.

Table1. Shows the list of abberivations

Index Number	List of Abberivations Used	Full Form of Abberivations
1.	MANET	Mobile and ad-hoc networks
2.	AODV	Ad- Hoc On-Demand Distance Vector
3.	RREQ	Route Request
4.	SPB	Smart Probablistic Broadcasting
5.	MPR	Multi point Relay
6.	DSR	Dynamic Source Routing
7.	WSN	Wide sensor network
8.	CDS	Connected Dominating Sets
9.	P2P	Point to Point
10.	AI	Artifical Intelligence
11.	PSO	Particle swarm optimization
12.	PSOPB	Particle swarm optimization Probabilistic Broadcasting
13.	RREP	Route Reply
14.	BSP	Broadcast Storm Problem

2. Related Work done

In this section, the author of this paper trying to define previous work in this domain. Furthermore, it presents a concise overview of the methodology and algorithm built for probabilistic broadcasting, as well as the prospective future scope. To do this study author use the Scopus dataset and make use of the information accessible from 2005 to 18th May 2021.

2.1. Extended Multipoint Relays to Determine Connected Dominating Sets in MANETs [3]

In paper [3] the concept of the muti-point relays was proposed. In a mobile ad hoc network, multi-point relays (MPR) allow decentralised as well as customised messaging transmission. Every other node locates a small number of forwarding neighbours from

which to send a message using partial 2-hop additional information, and this set includes the node's 2-hop neighbour set. Many other modifications are presented by the authors of this paper for generating a relatively small CDS while using proper 2-hop relevant data to shield each node's 2-hop neighbour set. The choice of energy-aware numerous relays was not considered by the author of this paper. Experiments and probability-based evaluation both validate the accuracy of the improvement. Furthermore, we show that the prolonged MPR has a persistent probabilistic absolute value whereas the precise MPR as well as its existing elaborations do not have this type of limit. Furthermore, we show that the long - lasting MPR appears to have an insistent probability - based absolute value, whereas the accurate MPR and its traditional extensions do not. Another research topic will be the examination of various non-uniform node distributions that could truly provide a consistent deterministic limit for the extended MPR.

2.2. A Neighbour Coverage-Based Probabilistic Rebroadcast for Reducing Routing Overhead in Mobile Ad Hoc Networks [4]

To shorten the route overhead in paper [4] hypothesised the Neighbouring Coverage-Based Probability - based Rebroadcast framework. Because nodes in mobile ad hoc networks (MANETs) are mobile, connectivity failures occur frequently, resulting in recurring trajectory errors and route breakthroughs. Broadcasting is a basic and efficient information distribution framework in route discovery. This paper's author proposes a probabilistic rebroadcast methodology based on neighbour coverage for lowering routing overhead in Manets. The author of this paper proposes a framework rebroadcast latency to evaluate the rebroadcast order to efficiently manipulate neighbour coverage understanding, and the author of this paper obtains a much more precise increased coverage ratio by signalling neighbour exposure awareness. The authors' proposed methodology combines the benefits of neighbour coverage understanding and the deterministic system, resulting in significantly fewer retransmissions, lower forwarding overhead, and improved forwarding productivity. According to results obtained, the proposed technique, unlike flooding and other optimised schemes in the research, produces less rebroadcast congestion. The observational results also show that whenever the system is preoccupied, the performance metric well, which means that congestion resistance is high.

2.3. MISTRAL: Efficient Flooding in Mobile Ad-hoc Networks [5]

The concept of effective flooding was proposed by the paper [5]. In this paper a simple flooding methodology that is heavily reliant on pro-active remuneration data packets

telecast on a regular schedule by each node. Using forward error - correcting methodologies, compensation data packets are constructed from missed data packets. The author of this paper executed Mistral after that altered the executable algorithm to the JiST/SWANS portal, allowing us to analyse actual algorithm in a virtual environment.
The results of the computation show that Mistral offers better node coverage than predominantly probability-based flooding with comparable overhead. Future research will look at system deployments using a framework of individual nodes, according to the paper.

2.4. Flooding in ad hoc networks is inspected using a variety of probability-based broadcasting effectiveness inspections [6]

In paper [6] a theory of effectiveness evaluation based on dynamic deterministic transmission was proposed. The standard blind flooding technique causes a broadcasting chaos and a large quantity of unwanted message rebroadcasts, culminating in higher supposition as well as data clashes. This journal investigates a novel probability-based approach for dynamically fine-tuning a node's rebroadcasting likelihood for transmitting demand data depending on the amount of nearby nodes. The presented methodology for the Ad hoc on Demand Distance Vector (AODV) forwarding mechanism is contrasted to static forecasting, as well as updated probabilistic flooding. The experimental findings show that our proposed approach outperforms blind flooding, static probability-based flooding, and adjusted flooding strategies.

2.5. A new probability - based broadcasting framework for mobile ad hoc on-demand distance vector (AODV) routed systems has been developed [7]

The idea of a modern probability – rely on transmitting methodology was suggested in paper [7]. The conventional approach of performing broadcasting is a basic flooding, which could also reduce Manet's efficiency. A flooding prediction model is currently being demonstrated as one of the most important anticipated approaches to the broadcasting storm situation, which results in colliding, confrontation, and subsequent messaging. This paper introduces the smart probabilistic broadcasting (SPB) method as an innovative suggested strategy for optimising the performance of existing on-demand routing systems by lowering RREQ overhead in the route discovery period. In comparison to AODV, which uses established likelihood and blind flooding, the study reveals that integrating AODV and an acceptable probability-based route discovery would reduce expected end-to-end latency and overhead, resulting in lower normalised routing load. To test our suggested framework computation observations were carried out. The findings show that SPB outperforms its

competitors, indicating a successful approach for optimised probability-based broadcasting.

2.6. A Pseudonymous Communication Protocol for Peer-to-Peer Technologies in Mobile Ad Hoc Networks [8]

In paper [8] the concept of the Effective Anonymous Interaction Framework for node-to-node Implementations was proposed. MAPCP deploys telecasts along with probabilistic-based flooding capability to build various anonymity ways among communication nodes. It has lower computational entanglement and energy requirements than the MANET anonymous routing protocol because it does not allow node-by-node authentication over anonymous routes. MAPCP appears to be more successful in P2P applications because it generates multiple routes to different groups within a single query phase, despite requiring an additional path exploration process. Via research and extensive experiments, the author of this paper shows that, even in a difficult setting, MAPCP retains a greater level of confidentiality compared to a MANET singular route mechanism.

2.7. Employing MANET Provincial Topological Information to Improve Route Discovery in On-Demand Routing Protocols [9]

In paper [9] optimising route exploration on request protocol was suggested. The most of existing routing algorithms designed for MANETs utilizing flooding as a broadcasting strategy for the dispersed of system control data. Flooding entails each cellular point transmitting the captured messages once more, which would then be distributed network-wide through substantial overhead. This paper tends to improve on the efficiency of already emerging routing techniques by minimizing the interaction overhead experienced throughout the route-finding procedure by creating a novel broadcasting approach named updated probability-based flooding system. The results of this paper demonstrate that it might help to minimize the overhead of the route exploration phase while keeping analogous output thresholds in accordance to optimise again broadcasts and ease of access as traditional AODV.

2.8. Assessment of Broadcasting Outcomes in MANETs and Wireless Sensor Networks Employing Leveled Probability [10]

The concept of Efficiency Analysis of Leveled Probability - based Broadcasting was suggested in paper [10]. By using intermediary nodes as relays, a mobile node and a sensor node could potentially share information with vertices outside of their transmitting

spectrum. The sender node sends out routing proposal datagram, which are resending to among all other vertex to find a path to a specific terminated node. In AODV, a simplistic flooding framework is used, with each node broadcasting these route demand data packets again even if some of its peers already have them, and then again broadcasts will accomplish no additional nodes. According to the findings, their methodology performs admirably the AODV protocol in most instances.

2.9. Evaluating the Performance of On-Demand Routing Protocols in MANETs Using Dynamic Probability-based Flooding [11]

In paper [11] the idea of efficiency analysis based on demand routing algorithms was proposed. The broadcasting method's productivity can influence the overall system efficiency. As a result, the simple flooding methodology exacerbates many unnecessary message repeat broadcasts, resulting in conflict and packet colliding. Suitable formulation Probabilistic methodologies may start to reduce the number of rebroadcasts, lowering the possibility of conflict and collision between adjacent nodes. An effective probability-based broadcast procedure could achieve high save-again broadcast while minimising conflict. The author compares an altering probability - based research methods wherein modules keep going to consider relocating in accordance with a way point mobility prototype to a simplistic flooding AODV and a stabilised probability - based strategy in this paper. In simulations, the methodology outperforms both simplistic flooding and specified probability-based flooding.

2.10. The Reliability of Normalized Probability-based Broadcasting in MANETs is being investigated [12]

In paper [12] the concept of Efficiency Analysis method focused on Estimated Probability-based Broadcasting was presented. Adequate utilization of a probability-based broadcasting technique in MANETs reduces the number of repeat transmissions, reducing the risk of conflict and conflict between adjacent nodes. The rebroadcast probability of low intensity networks is increased to maximise the saved again broadcasts, although it is reduced for extremely dense nodes. In contrast to sophistic flooding, our experimental outcome show that the updated probability-based flooding technique will increase saved broadcast accessibility by up to 50% without scanning, even under higher versatility and intensity conditions. In the future, the author plans to test the efficacy of Adapted Probability - dependent flooding on Dynamic Source Routing (DSR) algorithms. The author's aim is to provide an appropriate methodology for our solution to help in the

assessment of the best change strategy in the light of complexity layout and network strength.

2.11. Smart Broadcasting with a Novel Reach for Mobile Ad Hoc Networks [13]

In paper [13] the concept of a naval adaptive broadcasting approach was suggested. Mobile ad hoc networks (MANETs) have sparked a lot of interest because of advances in wireless technologies, as well as various innovations and implementations. The suggested method is focused on the often-used probability - based paradigm. The author of this paper carried out tests and observations to verify our proposed solution under different process parameters such as network intensities and given loads. According to the author of this paper, in future studies, the author of this paper intends to use the envisaged concept in additional contexts as well as large networks and can expect that proposed technique would enable us to execute, access, track, as well as manage MANETs more efficiently then current systems under varying functional conditions.

2.12. PSO-Based Malicious Node Detection and Energy-Optimized Grouping in Wireless Sensor Networks [14]

The concept of effective power cluster analysis, as well as suspect network detection, was proposed in the paper [14]. In wireless sensor networks (WSNs), suspicious node recognition is important so that the dishonest node does not reflect the network ruler. Furthermore, as the number of suspicious nodes grows, so does the probability of being a malevolent node as network leader. The author of this paper suggests a PSO-based suspicious cluster detection and node head sorting technique for identifying malevolent nodes and locating a cluster head with a high probability. The suggested methodology assigns a potential value to each node before selecting a high potential node to act as group leader. The suggested methods PSO-NMDC has proven to be the preferred solution where lower power usage and extended network lifetime are expected.

2.13. Fuzzy Probability-Based Broadcasting for Mobile Ad-hoc Networks [15]

The principle of probability-based broadcast utilizing fuzzy logic was introduced in paper [15]. Broadcasting can come in a variety of forms. The most basic of these is simple flooding, which would eventually raise overheads while also decreasing signals, exacerbating the Broadcast Strom crisis. The results of the implementation show that the

preferred approach is efficient and reliable in terms of absorbed energy performance, delay, conflict intensity, and lower normalised routing load.

2.14. Intelligent probabilistic broadcasting in mobile ad hoc network: a PSO approach [16]

The framework of intellectual probability - based broadcast was suggested in paper [16]. In these infrastructure-free schemes, streaming methods are widely used. Although broadcasting is an easy method for conducting routing and protection operations, it is a difficult or costly challenge to achieve in a large and mobile MANET. Probability – based [17] methods are often employed even though they do not impose any perceptible lag. This research paper's proposed study proposes and defines the most appropriate method for each node to designate the probability of transmitting again based on its neighbouring strength, available bandwidth, or residual power. The simulation findings demonstrate that the suggested particle swarm computation probability - based broadcast (PSOPB) strategy is more dependable & productive than existing AI- powered broadcast strategies.

2.15. Energy Efficient [18] Neighbour Coverage Protocol for Reducing Rebroadcast in MANET

To minimise re-broadcasting the idea of neighbourhood exposure standards was suggested in paper [19]. Wireless networks are conveniently adaptable to modifications and will provide system design versatility. Every node in a MANET will automatically update its location and customise itself based on the settings. By combining the incremental exposure ratio and even the communication factor, the again broadcasting likelihood is determined. In this case, the network should not forward RREQ until there is enough energy as well as the vertex intensity in its surroundings reaches a certain edge. Efficient Power Aware Broadcasts (EPAB) [20] is a revolutionary broadcast strategy that provides an effective route with suitable periodicity and battery capability EPAB will improve productivity by eliminating packet losses caused by nodes that do not have adequate battery power to transport the datagram to the next location. The DPR mobility node estimates the Node's Forwarding Possibility (NFP) adaptively based on the intensity of close neighbour nodes [21]. The study developed the concept of computation and evaluated the usefulness of probability-based broadcasts in the Fisheye Condition Forwarding routing algorithm in MANET using any mobile paradigm [22].

3. Bibliometric Analysis of Probabilistic Broadcasting in Mobile Ad-hoc Networks

This section discusses bibliometric reviews on Probabilistic Broadcasting in Mobile Ad-hoc Networks for several applications. The primary aim of this paper is to assess the amount of work done in the field of Probabilistic Broadcasting in MANETs, as well as to predict the future scope in this field. In this paper we did a bibliometric survey of last 15 years from 2005 to 18th May 2021 and Scopus is the source of the whole database.

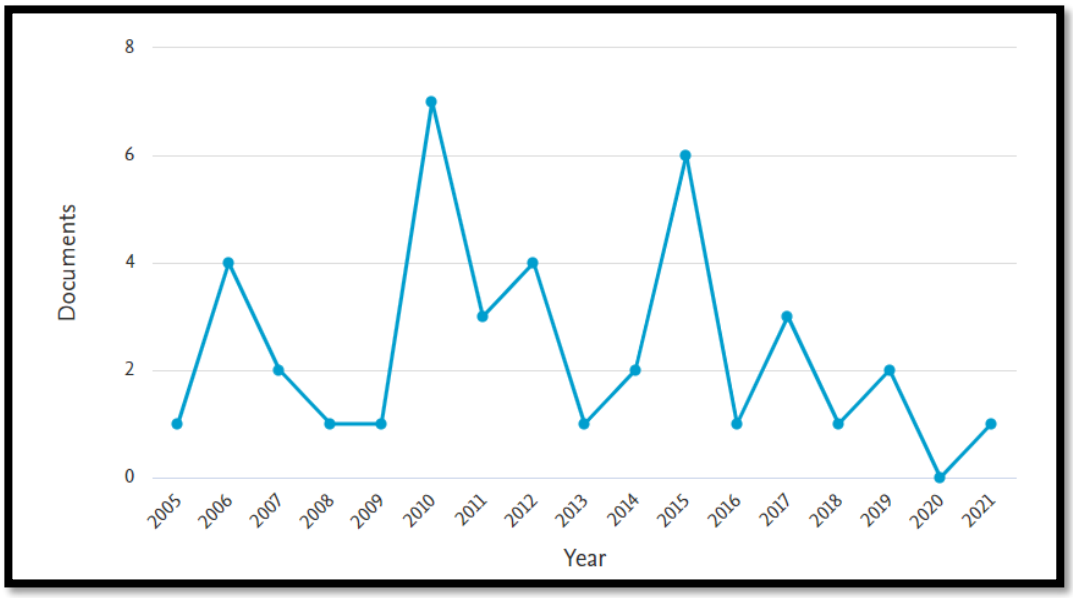

Figure 3. Shows the Documents Published Per Year

Fig. 3 shows the analysis of number of documents published per year. Here we did the bibliometric review for last 15 years from 2005 to 18th May 2021. From the figure 3 we can analyze that maximum number of documents were published in the year 2010 with a count of 7, while the minimum number of documents were published in the year 2020 which was zero (0). In year 2005 the number of document published was 1 (one), followed by year 2006 with a count of 4. After that graph is decreasing and in year 2017 number of documents published were 2. After that graph is remain constant between 2008 to 2009 number of document published was one in each year. Then graph is increasing it shows maximum number of documents were published in 2010 with a count of 7 which was followed by 2011 with a count of 3. In 2012 the number of documents published were 4. In year 2013, 2016, 2018 and 2021 the number of document published was 1 in each year. While in year 2014 and 2019 number of documents published were 2. In year 2015 number of documents published were 6. While in 2017, 3 documents were published. In figure1 we can see the graph is in the zig-zag form.

In Figure 4 graph shows the number of documents published per year by source. Here authors did a bibliometric survey of Probabilistic Broadcasting from 2005 to 18th May 2021. Different colour in the graph indicates the different sources. In year 2010 and 2011 number of documents published was one (1) in the source Communication in Computer and Information Science which is represent by green colour line. While in 2012 the document was published in source Aip Conference Proceedings with a count of one followed by the year 2015, shows that the documents published in this year with a count of one, and published in the source Computer Networks which was represented by violet colour in the figure4. In year 2019 the number of documents published was one, in source Advances in Intelligent Systems and Computing.

Figure 5 as well as table3 depicts the documents issued by top ten authors also their contribution. It shows that the maximum number of documents was published by AI-Dubai, A.Y. and Chandrasekhar, C. with a count of 3. Followed by the Adarbah, H.Y., Ahmad, S., Awan, I., Chaba, Y., Dembla, D., Hanashi, A.M., Khaoua, M.O. and Mackenzie, L.M. with a count of 2.

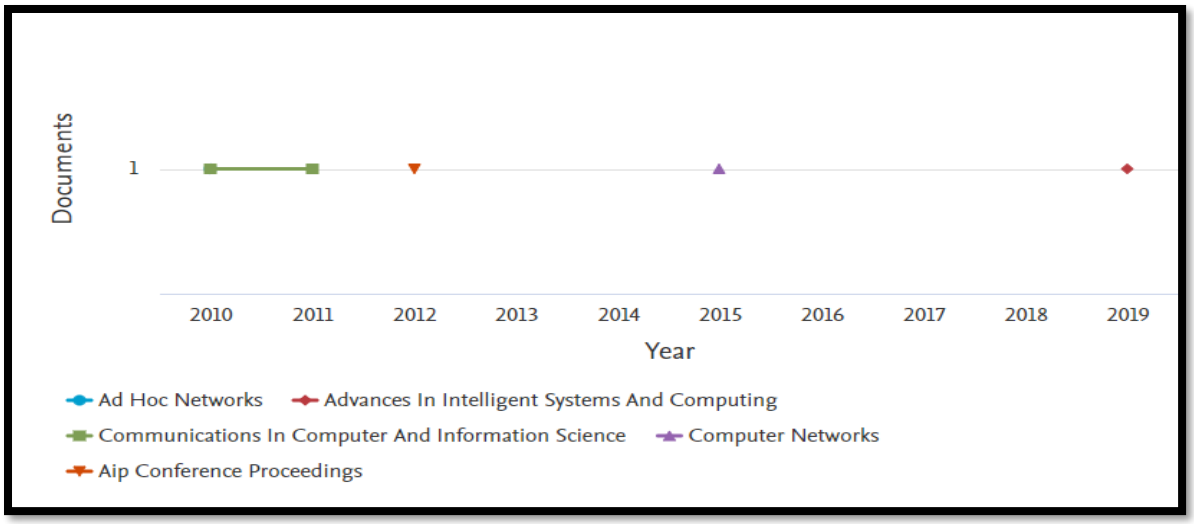

Figure 4. Shows the Paper Published Per year by various source

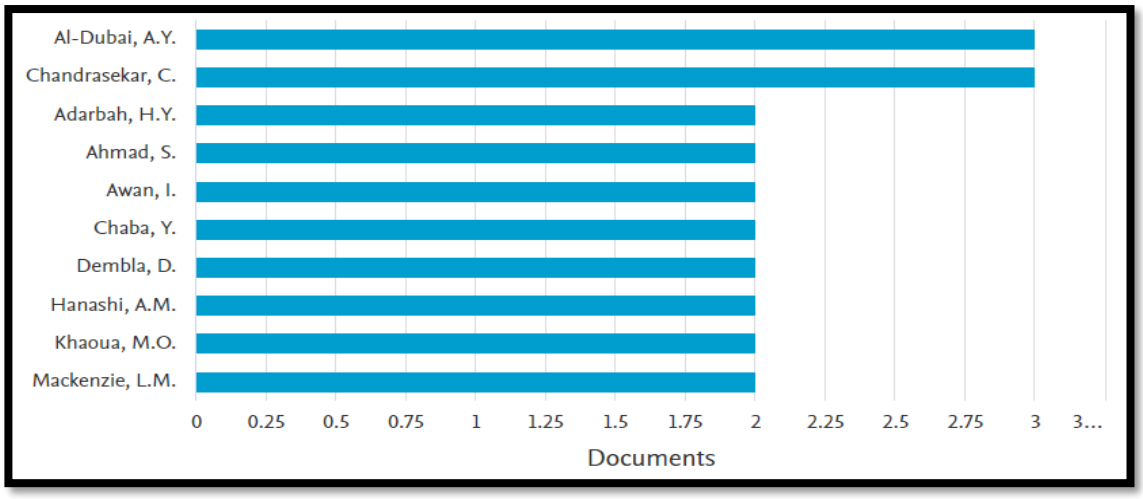

Figure 5. Shows the contribution of top ten author

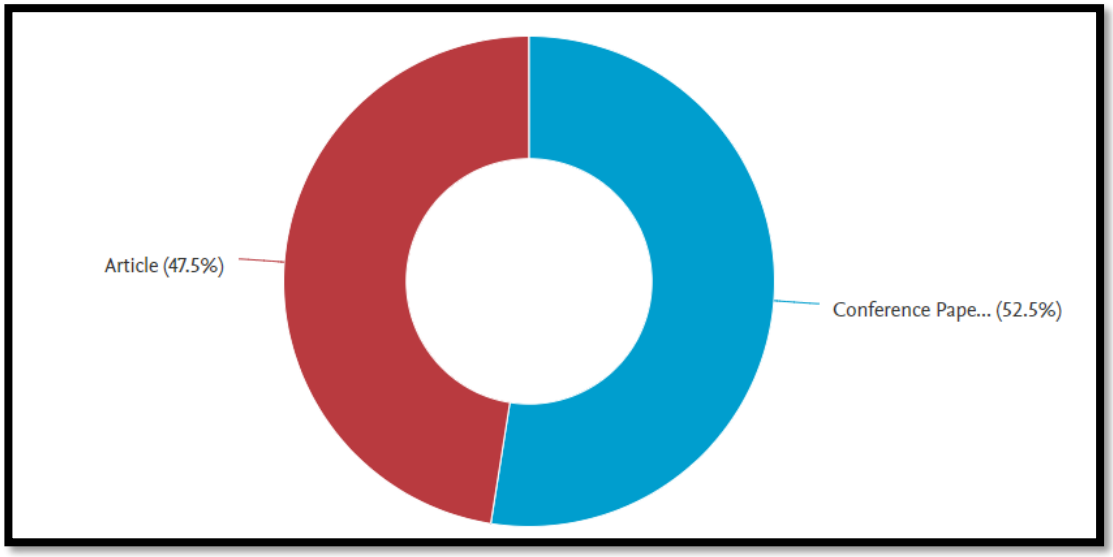

Figure 6. Shows the documents by type

Figure 6 shows the number of documents published by type. From the figure6 we can analyse that the documents are published only in two types. From the figure4 we can analyse that the maximum number of documents was published as Conference paper with a count of 52.5% followed by the article with a count of 47.5%. From the figure4 we can analyse that the documents are published only in two types. The author of this paper did a bibliometric survey in the field Probabilistic Broadcasting in Mobile ad-hoc networks and complete data is taken from the scopus. From figure 7 as well as table 2 we can analyse that the documents published by top 15 universities. Periyar University published maximum number of documents with a

count of 4. Number of documents published by University of Glasgow and Edinburgh Napier University was 3. Followed by the University of Science and Technology, Cornell University, University of Bradford, Jordan University of Science and Technology, SNS College of Technology and Christ College of Engineering and Technology with a count of 2. Though Info Institute of Engineering released the least amount number of documents with a count of one.

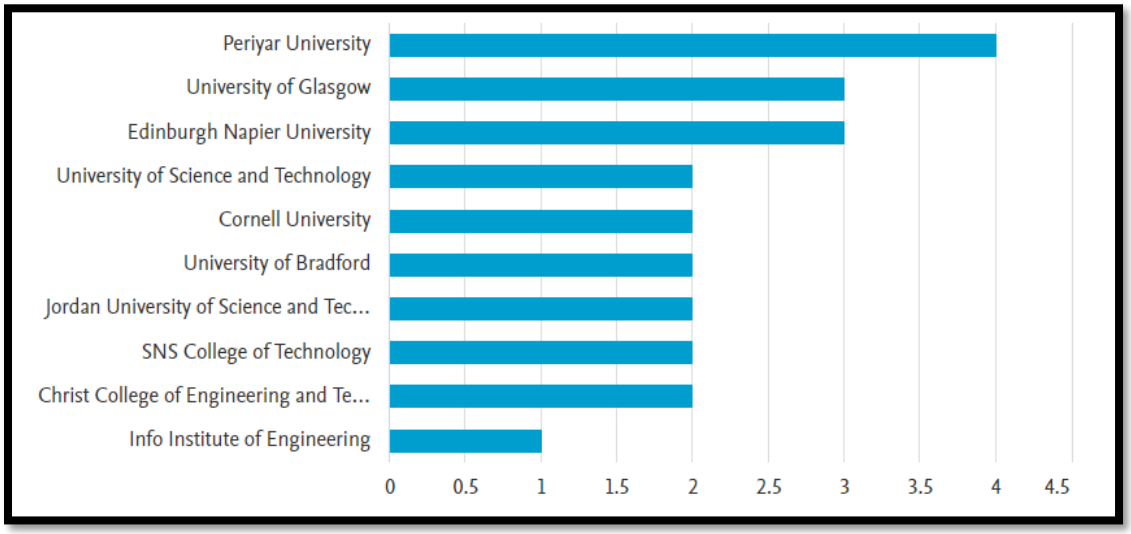

Figure 7. Shows the Documents published by affiliation

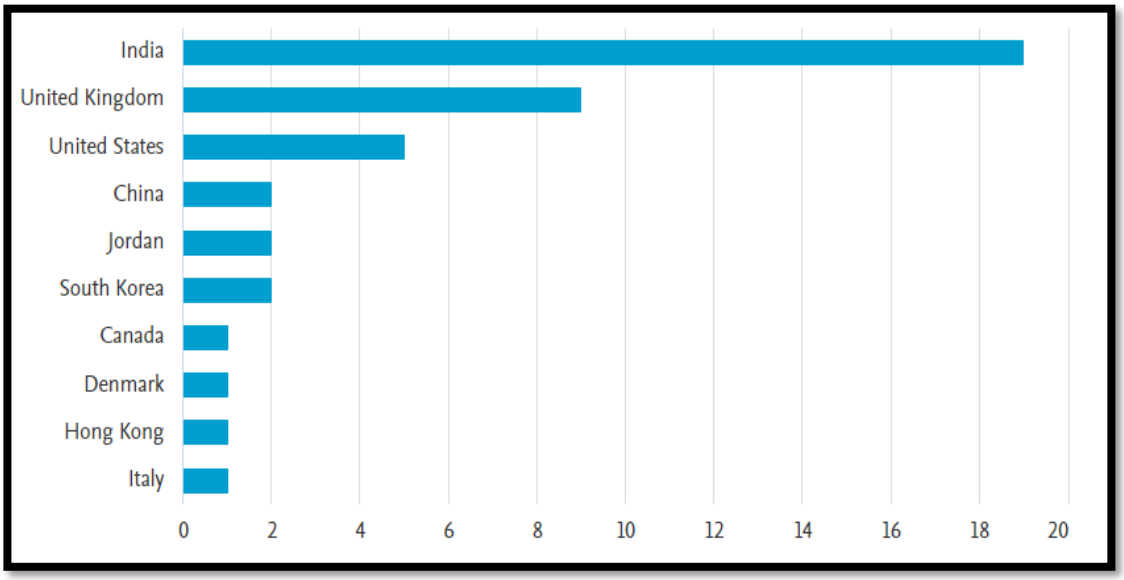

Figure 8. Shows the Documents published by Country or Territory

Figure 8 shows the document published by country and territory and in figure11 it is shown over the world map. From the given figure we can analyse that the maximum number of

documents was published by India with a count of 19 while the minimum number of documents was published by Italy, Canada, Denmark, Hong Kong with a count of one (1). Number of documents published by United Kingdom was 9, followed by the United States with a count of 5. China, Jordan and South Korea published 2 documents. Here we did a bibliometric survey of last 15 years and the complete data is taken from the Scopus. Figure 9 depicts the percentage distribution of Probabilistic Broadcasting of MANETs documents in different disciplines. From the figure 9 we can analyze that the maximum number of documents was published in the field of Computer Science with a count of 48.6%, followed by the Engineering field with a count of 20.8%. In the area of Mathematics only 15.3% documents were published. Business, Management and Physics, Astrology contribute 2.8% followed by Agricultural, Biochemistry, Decision Science, Earth & Planet and Environmental Science with a count of 1.4%. While 2.8% documents were published by other domains. Figure 10 shows the documents by different funding sponsor therefore we can analyse that there are three funding sponsor which contribute to this field. Japan Society for the Promotion of Science published one paper followed by the Ministry of Education, Culture, Sports, Science and Technology with a count of one (1). Number of documents published by National Science Foundation was one. The entire funding sponsor contributes equal in amount with a count of 1.

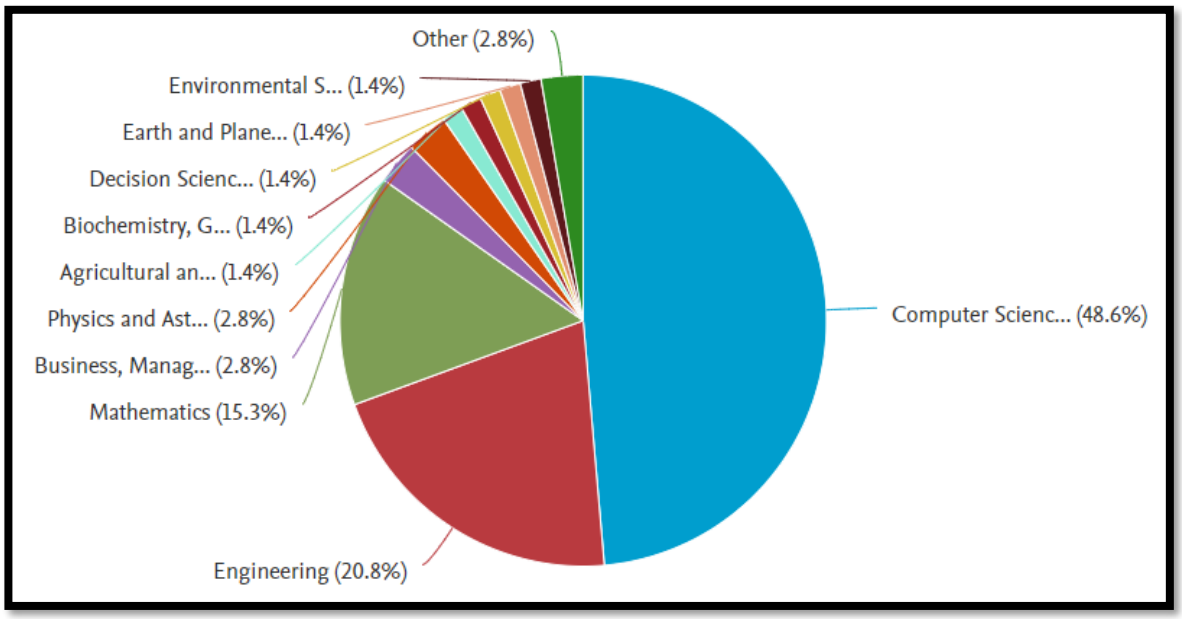

Figure 9. Shows the Documents published in subject area

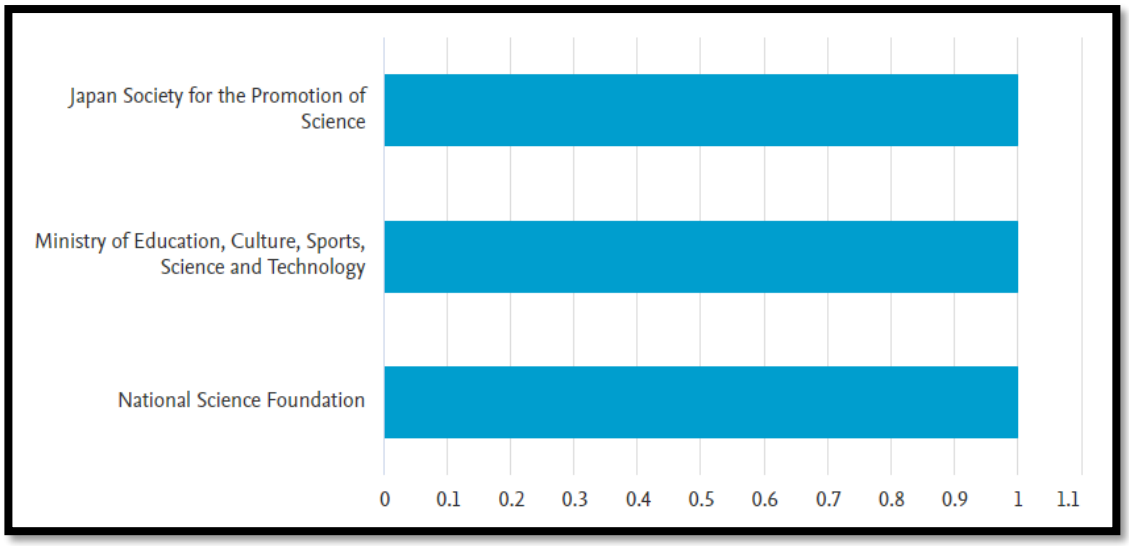

Figure 10. Shows the Documents by funding sponsor

Figure 11. Represents the documents issued by various countries on world map

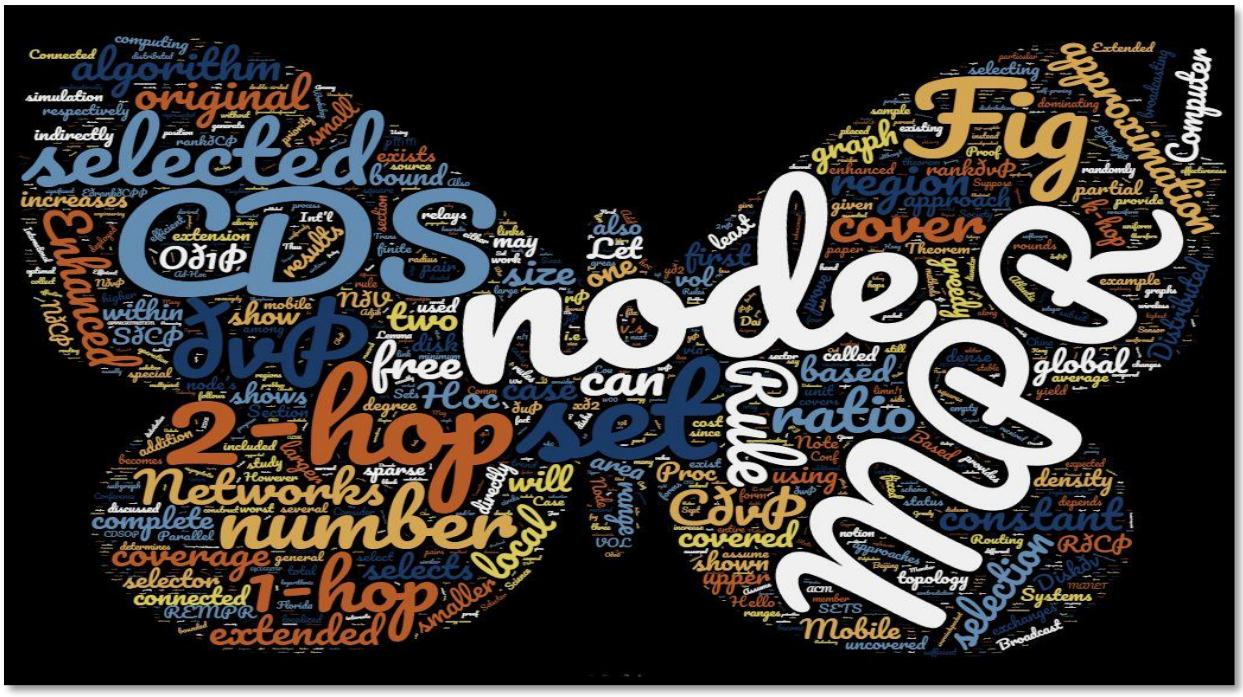

Figure 12. Depicts the relationship between the co-occurrence of keywords

Figure 12 represents the relation between the occurrences of keywords. By using the wordclouds.com we can generate this graph.

Figure 13 depicts the cluster of papers released in the relevant year. Based on the data, we can conclude that the bare minimum of documents was issued in 2007. This graph was developed with the NodeXL method.

Figure 14 depicts the linkage among the important journals, keywords, and important authors. We will create this graph and be able to analyze the relationship between them with the help of the ScienceScape website.

Figure 13. Shows the cluster of documents published in respective years

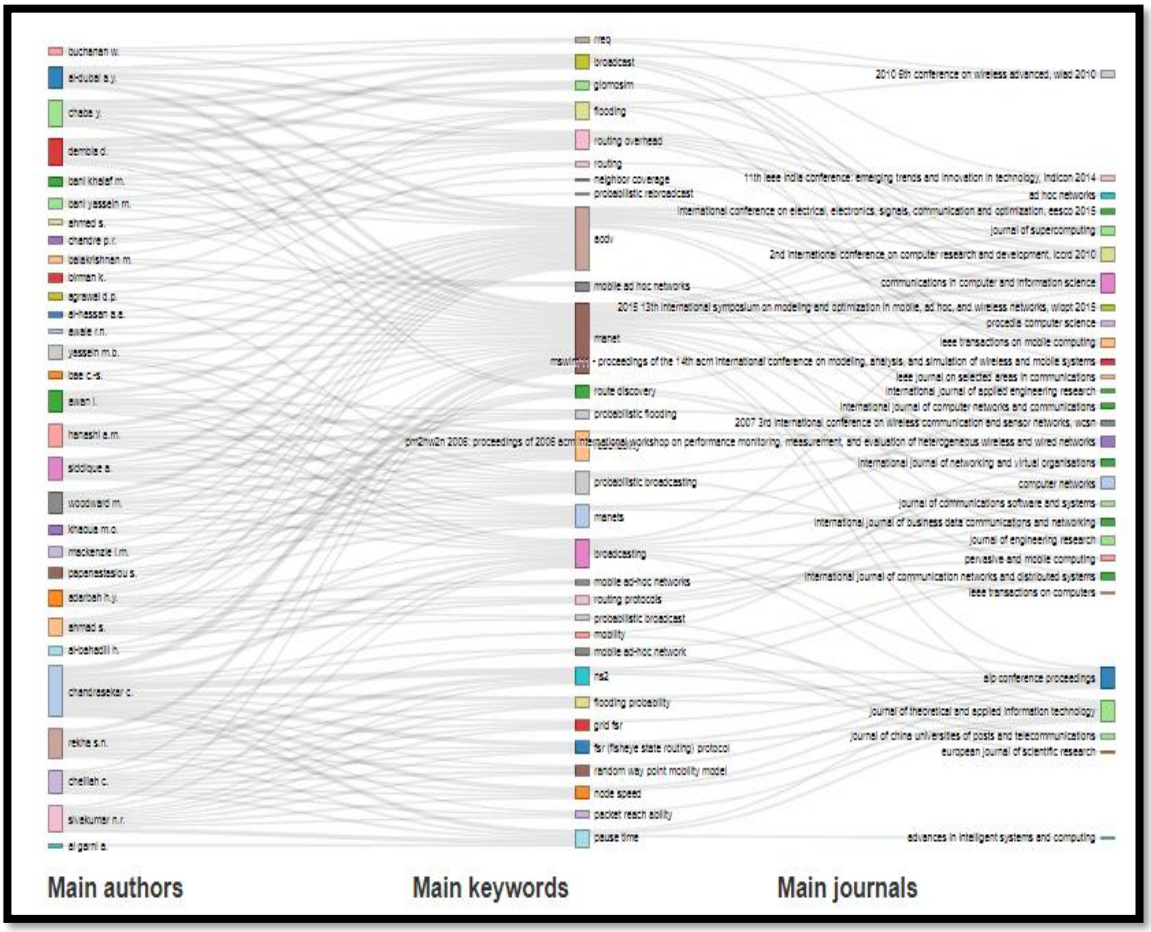

Figure14. Shows the association between authors, keywords, and journals

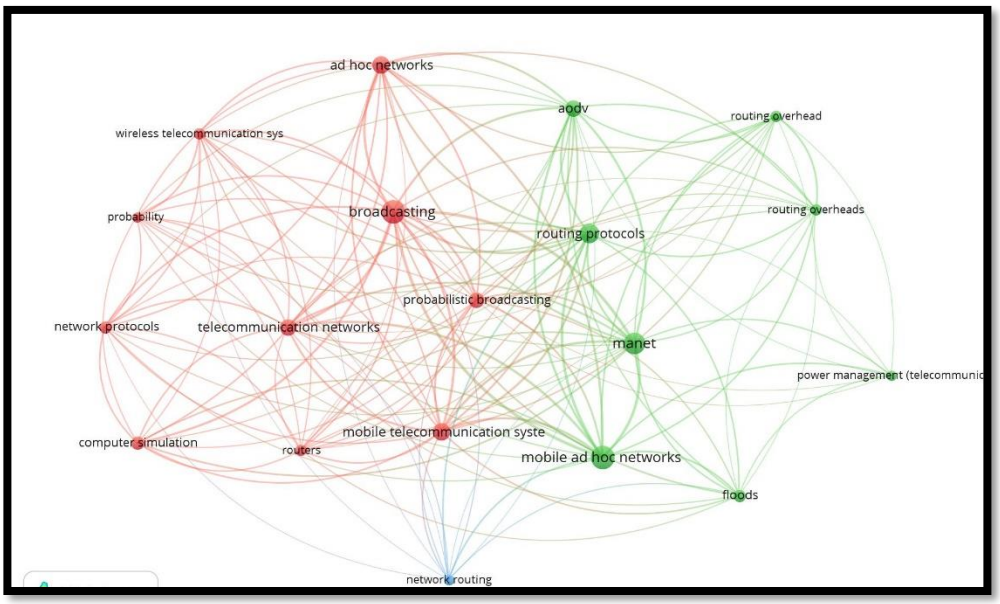

Figure15. Depicts the relationship between all keywords

We can plot the figure15 by using the VOS viewer tool. From the figure15 we can analyse the relationship between all keywords. Figure 15 depicts the title keywords as a circle, with the size of the circle representing the count of times the keyword has been used.

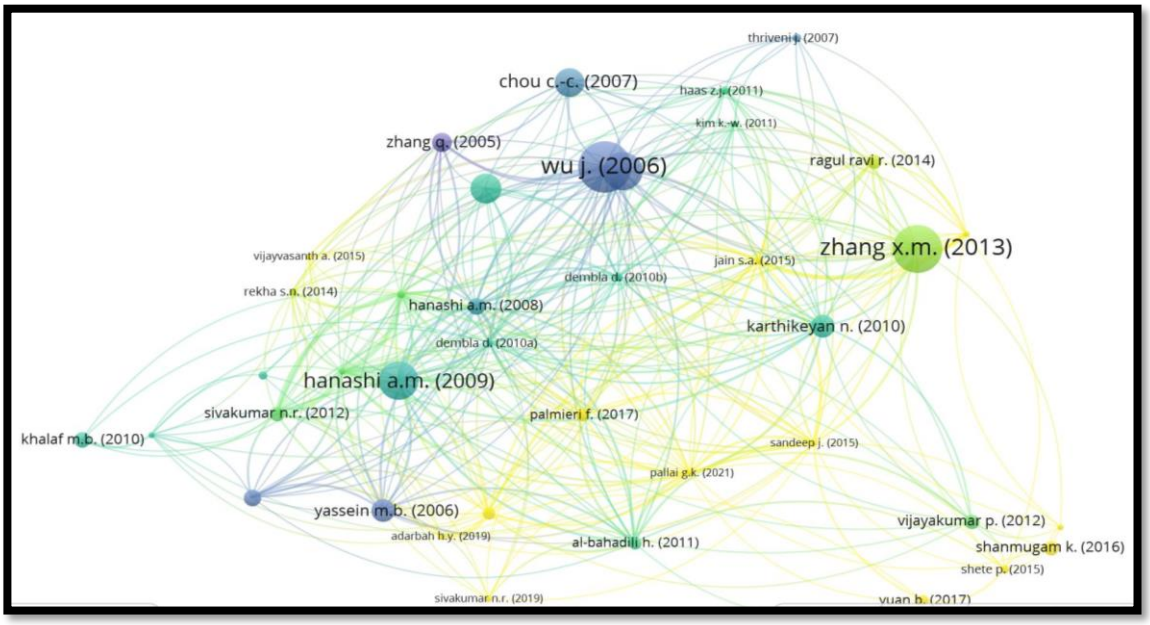

Figure 16. Shows the Bibliographic Coupling of documents

Figure 16 allows us to examine the bibliographic interaction of papers. We get the csv file from the Scopus database and specify a time range of 2005 to May 18th, 2021. This figure will be created using the Vos viewer tool. Figure 16 depicts the author's name as a circle, with the magnitude of the circle representing the number of times it has been coupled.

Table 2. Number of documents published by top ten universities

Sr. No.	University Name	No. of Papers Published
1	Periyar University	4
2	University of Glasgow	3
3	Edinburgh Napier University	3
4	University of Science and Technology	2
5	Cornell University	2
6	University of Bradford	2
7	Jordan University of Science and Technology	2
8	SNS College of Technology	2
9	Christ College of Engineering and Technology	2
10	Info Institute of Engineering	1

Table 3. Shows the details of number of papers published by top ten authors

Sr. No.	Author Name	Count of Paper Published
1	AI-Dubai, A.Y.	3
2	Chandrasekhar, C.	3
3	Adarbah, H.Y.,	2
4	Ahmad, S.,	2
5	Awan, I.	2
6	Chaba, Y.	2
7	Dembla,	2
8	D.Hanashi, A.M.	2
9	Khaoua, M.O.	2
10	Mackenzie, L.M.	2

4. Conclusion

This bibliometric study was conducted to illuminate the amount of work done on the probabilistic broadcasting of MANET protocols and its future scope. Provides details of publication counts in various journals, countries, academia, and publications per year. Most importantly, the analysis done on the publications per year shows that there are still many gaps in the probabilistic broadcasting of MANET protocols. The authors also elaborate on network analysis of keywords to describe the link between different keywords. It will serve as a guide for new researchers to refer to the research work of various authors depending on their publishing or counting number of articles. Also, this bibliometric study makes it easy to find journals with as much detail as probabilistic broadcasting of MANET protocols and to direct journals for work publications.

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